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SOFTWARE SUPPORT OF ENVIRONMENTAL MANAGEMENT SYSTEMS

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Abstract

Building up of *Environmental Management Systems* as per *ISO 14001* standard – in harmony with the continuous development 'spiral' – requires the integration of – a controlling approach – the so called *environment controlling* – into the Company's management system, which has an essential part – speaking about controlling – the building up of a Company Environmental Management Information (Sub) System and implementing it into the company information-management system. Practical presentation and operational practice of this *Environmental Management Information System*, its structure, the phases of its building up, the introducing and the operation practices with the help of the *TECHNO* and *QEMS(KIR)* software packages.

Keywords: EMIS.

1. Introduction

STANDARDS, EMS, IMPORTANCE OF ENVIRONMENTAL (PROTECTION) INFORMATION SUB-SYSTEMS

'The development and maintenance of an *Environmental Management System*[1] conforming to the internationally accepted standards (BS 7750, EC EMAS 1836/93 regulation, ISO 14000 standard series) fully ensures the optimising of the risks of operation from environmental point of view' – can be read frequently.

Though in practice the developing and maintaining of a system like this involves a lot of work and duties, the major part of it being *repeating, regular* activities, that are mainly *data collection, evaluation, measuring, correction, documentation....*

In the spirit of standard ISO 14001 the operation and maintenance of a full EMS system requires a Company with process orientation and which can continuously develop and which can justify its environmental performance with data as fact, the operation of which is based on consecutive *PLANNING – EXECUTION AND*

[1] Later referred to as EMS

OPERATION – CONTROL AND CORRECTION CYCLES where the decisions are made on the basis of properly collected and evaluated information.

The proper provision of the above activities requires as to the environmental activities a *management* system working under a *controlling* approach from the Companies building up the system and seeking certification.

What is controlling approach?

Now the traditional controlling approach and its interpretation shall be highlighted in the EMS system, integrating it into its operation.

Controlling is the summary of management partial functions where the provision of information ensures the harmonised and co-ordinated operation of the *planning and supervision systems*. The controlling activity creates the harmonised co-operation of the partial processes of the company and by that it supports the actions of the management by the means of *planning-controlling methods*, calculations and different analyses, in an *innovative way promotes* and ensures the necessary information for the quick and flexible decisions of the company management (HORVÁTH, 1993).

In other words the aim of controlling is to maintain the co-ordination, reaction and adaptation capability of the management in order to reach the company's goals.

This is also true for the so called *environment controlling* developed for the controlling of environmental activities, the aim of which is to maintain the *co-ordination, controlling, reaction* and *adaptation* capability in order to reach the environmental goals of the company with proper *environmental protection information service*, ensuring the *planning and supervision* system in connection with the environmental activity.

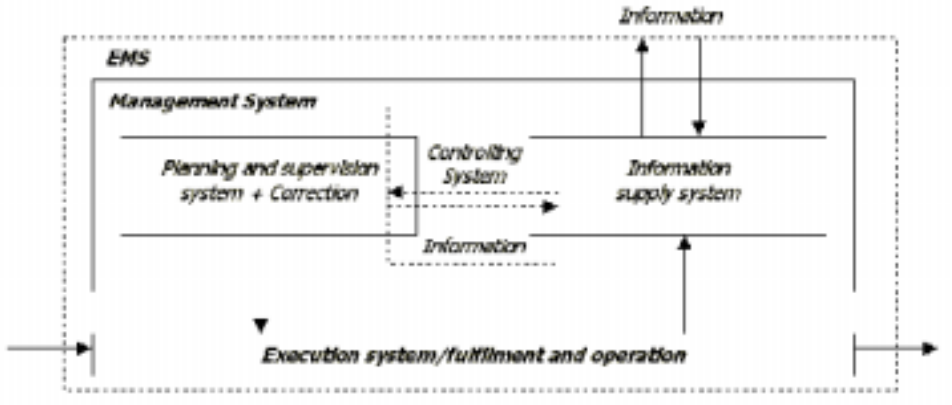

Fig. 1.

As a conclusion from the above definition of controlling, its basic task is the co-ordination of planning, controlling and information supply. We shall see it in a system oriented point of view, that means that the system should be imagined as an orderly set of elements between which there is a definite relationship. Such

an interpretation of the system enables the analysis of complex relations within the company, for instance revealing the relationship between planning, controlling and information supply and also makes it possible to highlight the ever current dimensions (e.g.: information projection).

Within the company we have to make distinction between the *management* and the *execution* systems. The controlling function is within the frames of the management system (HORVÁTH, 1993).

Our findings in connection with *Fig. 1*.

- Planning and supervision are central management duties, which requires special treatment due to its complexity.
- Satisfying the information need of the management is a special problem, that has facilitated the introduction of the controlling function at many companies.
- Planning, controlling and information supply have to be harmonised with each other.

The controlling system creates the necessary harmony as a co-ordinating system.

While in the planning and supervision system they start from the given set of information, then in the information supply system it is the improvement of the information which is reached. The information supply system is consequently the input of the planning and supervision systems.

Co-ordination covers the following:

- Determining the information need, that is creating the harmony between the information demand and possibility.
- Collecting and processing the information.
- Transmittal of information, and here the reports have the highest importance.

We shall have a look at the adaptation of the above conception in the case of the environment controlling/management system:

- Management also requires an immense quantity of information as to environmental information, which originate from company technologies, authorities' regulations and the requirements of the standard.
- There is a need for the integration of a so called environment controlling conception into the EMS that supports environmental planning, that is shaping of the environmental objectives, programmes, strategies – as an input – with proper information – which information has to be able to be measured – and also means the basis for supervision that is it has a so called co-ordinator role.
- The co-ordinating role of the *Environment controlling* system manifests in the registering and evaluating of (essential) environmental effects and to meet the requirements of the subject, as well as to create the harmony between the information needs and possibilities conforming to company practice, in unified evaluation of information and in supporting the reporting needs (ROMHÁNYI, BODNÁR and VÁMOSI, 1996).

So the *EMS* system in the spirit of the *ISO 14001* standard and using the controlling conception can be depicted as stated above that is in harmony with the 'spiral' of continuous development (ISO 14001:1996), though it handles certain elements of this in an integrated way in accordance with the practical operation.

It can be seen from the above that the EMS system urges the realisation of a controlling approach at the companies introducing the standard, but if it is about controlling than *information technology (IT) background a software backing* that registers and evaluates the immense quantity of information ...

So at most of the companies which adopt the operation philosophy conforming to the above criteria these data, information, functions necessary for the environment controlling are mainly improper in the company management systems and are almost totally missing – e.g. there are no environmental data at all, no environmental costs .. – now therefore it is obvious that the effective operation of EMS in accordance with the ISO 14001 standard requires the creation and operation of a reliable environmental management information sub-system. While the environmental audits establish the planning of the changes but they do not support the analysis of different development scenarios and choosing the most optimal solution from environmental and economic point of view, than the environmental management sub-system makes possible the *planning of* environmental *data, effects* and the *continuous follow-up of the changes*, so promoting the establishing and continuous *justification* of the *continuous environmental protection development*.

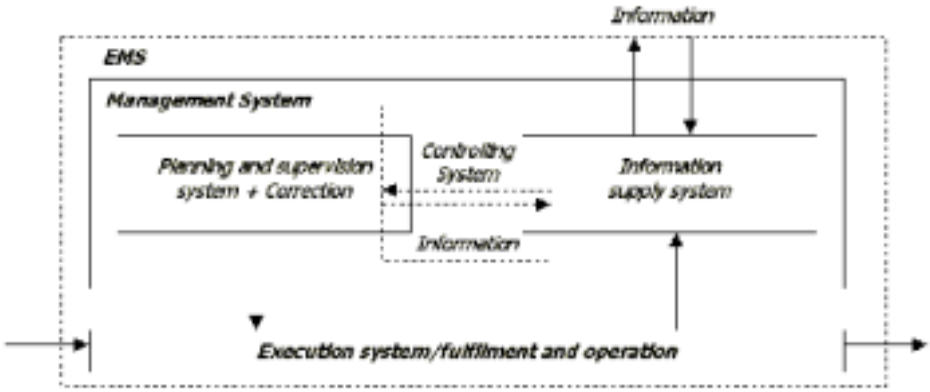

Fig. 2.

The environmental system as per ISO 14001 requires IT (software) support in the following fields (ROMHÁNYI and BODNÁR, 1998):

- for the evaluation of *environmental performance* and the justification of the continuous environmental protection performance with taking into consideration the ISO 14031 and ISO 14032 standards,
- identifying the *environmental factors*, knowing its quantity, its analysis capability, its interpretation capability,

- calculating the effects of the system-interventions causing the changes of *environmental factors*: system simulation,
- measuring, calculation and planning of the *environmental costs*: environment controlling,
- meeting and evaluating the legal frames, limit and fine calculations,
- registering the *authorities' expectations*, supporting their fulfilment and evaluating their satisfaction,
- handling the *information concerning crisis situations*,
- preparation of *environmental objectives* as plan values and evaluating their fulfilment,
- handling the *textual documents* of the environmental management system by ensuring the competencies, validity issues, etc. determined in the standard.

The effective operation of environmental management can be ensured only with the help of an *Environmental Management Information Sub-System*[2] which performs the above duties, and which has the specialities of an information system supporting the traditional company controlling system – as we shall later see – in the context of environmental issues.

From the point of view of building up the system – the phases of which shall also be presented – some important criteria shall also be presented which determine the depth of the known supporting softwares in the system to be built up:

- *Determination of the information need*. In what depth we want to handle our environmental protection data, effects.
  First of all the determination of the organisational frame belongs here which happens by determining the person to do the duties and the time intervals – the length of time within the analysis of the information need is prepared.
- In the next step it is determined how the collection and preparation of the information contributes to the covering of the communicated information need. Whether the pieces of information are needed in the strategic or the operative planning, the information sources might be different.
- Finally, the working information collection and preparation requires clearly defined spheres of liability, namely the determination
  - who collects the information,
  - who prepares the information,
  - who co-ordinates the whole process.

The process of information transmittal is determined by the structure of the reporting system – form and depth of reports. The reporting system is the facilitator of the management measures – see management audits – since the reports confront the values prescribed by planning with the realised factual values.

The *reporting system* is a supplement to the planning system, since one of the important aims of planning is improving the management of the company.

[2]Late: EMIS

The aims to be reached by different spheres of liability are determined in the objectives, plans in the form of specific plan figures. Management shall be effective when the planned indexes are regularly compared to the factual or expected data.

The comparing analysis may reveal the reasons of the differences and therefore may provide a starting point for some *correction measures*.

In the frame of the reporting system the information is summarised and then transmitted in a proper form towards the management. The reports have to show how each department of the company could reach its objectives and if they have to be assisted with additional measures in reaching their objectives.

In the following part we shall present the conception – the elements, the building up potentials – of this above described system – in a short introduction.

2. Introduction of EMIS

We shall introduce the structure of the Environmental Management Information System with *Fig. 3*. Basically we can speak about two systems which support the building up of a system as per ISO 14000, and they are strongly linked to each other, though they are able to support EMIS alone as well (ROMHÁNYI and BODNÁR, 1998):

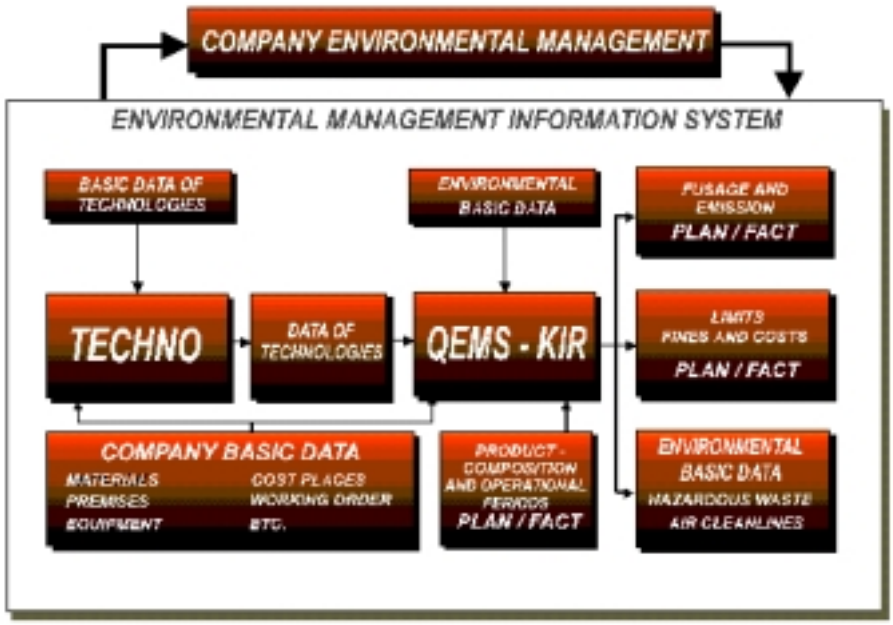

Fig. 3.

1. A 'more professional' – *TECHNO PROGRAMME SYSTEM* –, with the help of which the information basis of the Environmental Management System (EMS) might be established professionally the best way and which is able to fully support an environmental *status appraisal, effect analysis, environmental risk evaluation*, technology modelling, system simulation.
   This software – being an expert system – has a need for immense data, the maintenance of the database requires fairly lot of work, so it is advised to use it better in such fields, where the precise modelling of the technologies is necessary (e.g. chemical industry, energetic industry, etc...)
2. The *QEMS(KIR)* module system software package, which assists and supports the operation of the already introduced ISO 14001 system. Supported areas: maintenance of environmental protection databases, environmental effect evaluation and analysis, handling of environmental management documentation, measuring, justification of environmental performance, etc...

In practice it is expedient to perform a detailed status appraisal with the TECHNO 'professional' system, which results in preparing the *technological* and *environmental database* and a detailed evaluation is prepared about the environmental effects. Based on the environmental database prepared like this, for the supporting of the operation of EMS the basic modules of *QEMS* are advised to be used, with the help of which the database shall be maintainable, the status appraisal, effect evaluation and analysis shall be reproducible with low input of work, you will be able to get out information from the database in lot of ways, the continuous environmental improvement shall be justifiable.

We shall now introduce both of the software packages with an overview nature:

3. Introduction of the Software Packages

TECHNO 'PROFESSIONAL' PROCESS ANALYSIS AND EFFECT EVALUATING SYSTEM (ROMHÁNYI and BODNÁR, 1999)

Methodological bases of technological modelling:
We use Flow Diagram Models (FDM) for systematic modelling and analysis of the technological processes. The model is the TECHNO programme system.

Aim of the method

Proper precise modelling of the material and/or energetic processes taking place in technological systems, in order to determine the whole material and energy quantities entering and leaving the system, their time factors and their cost factors.

We show the *operation* of the system on the following figure:

Basic information needed for the operation:

Material and energetic flow diagrams of the technologies, the basic data of the materials, energies used during the technologies – time and cost data of technologies..

Services of the system

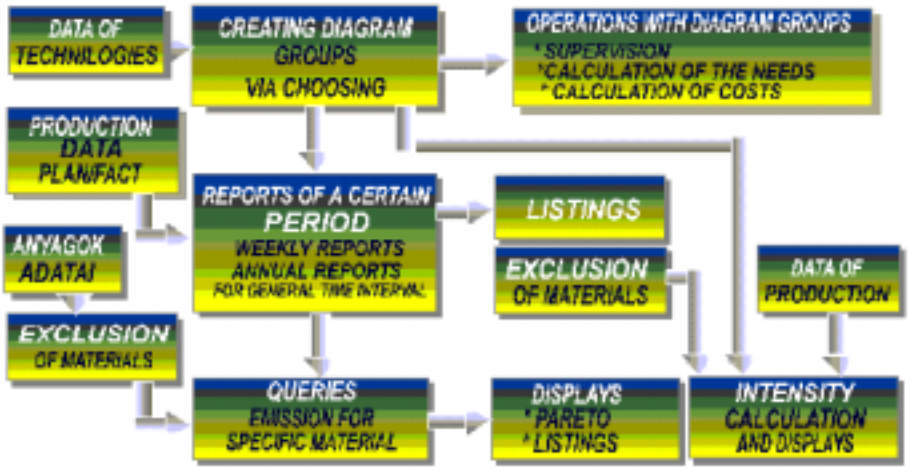

Fig. 4.

- Supporting, specifying the professional examination of the technologies, preparation of a technological database;
- Calculating the used and emitted material quantities of the technologies starting from the planned quantity of the product or from the production factual data;
- Calculating the time division of the emissions (pollution) coming out from the technologic system for an optional time interval;
- Knowing the planned product quantity, the expected data of the materials created together with the product (waste material, air pollution, waste water);
- Following the way of the materials coming out of the technology and analysing the costs in the interest of optimisation;
- Material proportional and time proportional cost of the technological processes at an optional point of the technological process, the economic evaluation of the technology;

QEMS(KIR) MODULE SYSTEM SOFTWARE PACKAGE

QEMS(KIR) consists of the following modules:

1. *QEMS*EMS
   - *QEMS*Base
   - *QEMS*Record
   - *QEMS*Anal
   - *QEMS*Query
   - *QEMS*Perform
2. *QEMS*Waste
3. *QEMS*Word

QEMSBASE (BASIC DATA REGISTERING AND MAINTAINING SOFTWARE MODULE)

- It handles the basic data of the environmental management system as per ISO 14000: *materials, equipment, cost places, premises, competence...*
- It handles the data necessary to meeting the authorities' requirements: data of calculating the data of *hazardous waste, air polluting materials, limits, fines...*

QEMSRECORD (DATA REGISTERING AND MAINTAINING SOFTWARE MODULE)

1. Data necessary for the operation of environmental status appraisal, environmental management and the EMS
   - Their registering and controlling,
   - Modification and controlling and
   - Listing.
2. It is able to receive the data of the company information system: may be adjusted to the company information system.

QEMSANAL (ANALYTICAL MODULE)

This module contains the calculating and evaluating algorithms of the *technological processes* in the fields of environmental status appraisal and environmental management establishing the environmental management sys- tem.

The functional groups within the module are the following:

☑ *Emissions of one period* and their summary
☑ Identifying, excluding emissions causing *significant changes*
☑ Evaluation, calculation of *environmental risks*
☑ Calculation of *Environmental protection costs*, with environment controlling
☑ Calculation of the costs of transregression of *Environmental protection limits, fines*

QEMSQUERY (QUERY, DISPLAYING MODULE)

In this module of *QEMS* the data registered and controlled by the help of *QEMS*RECORD and processed by *QEMSANAL* may be queried and displayed graphically.

The searching restriction possibilities supported by the module are the following (combination of searching restrictions is also possible):

☑ Query for a *certain period*
☑ Query for *effects caused by a specific material* (e.g. CO quantity emitted into the air)
☑ Query for *effects caused by material groups* (e.g. all polluting materials emitted into the air)

☑ Query for *technologies, equipment*
☑ Query for *organisational units, cost places, factory, company...*
☑ Query for *costs*

QEMSPERFORM (ENVIRONMENTAL PERFORMANCE EVALUATING MODULE)

It supports the evaluation of the environmental performance by analysing the many years emission data.

The following functions are fulfilled by it:

☑ Evaluation of the annual *quantity* of emission
☑ Evaluation of the annual *cost* of emission
☑ Calculation of the *tendencies* of the emissions
☑ Weighed summing of the tendencies of the emissions, calculation of the performance of the period
☑ for equipment – technology – factory – premises - company

QEMSWASTE (WASTE MANAGEMENT MODULE)

This is the software solution for waste management as per the new environmental protection decree (102/1996 /12. VII./).

The following functions are fulfilled by it:

☑ Registering of partners
☑ Registering of contracts
☑ Waste containers and their stocks
☑ Waste supplies and expeditions, preparation of bills
☑ Costs of wastes
☑ Annual confession of hazardous waste

QEMSWORD (DOCUMENTATION HANDLING MODULE)

This module is a computer solution for handling the textual documents necessary for the introducing and application of *environmental management system* as per ISO 14000 standard.

Possibilities offered by the software:

- possibility to document the changes;
- reliable, quick updating of the data used in the document;
- the documents are stored in a coded way in order to evade unauthorised viewing and modifying;
- it is able to store the modifications and to create or re-create former statuses;
- viewing and modification based on personal competence concerning any part of the document;
- storing of different text variations for the same topic areas and supporting of the creation of new documents;
- shortening and amputating of textual documents as per a formerly defined system of criteria, viewing and printing of the versions being created this way...

4. Possibilities of the Software Support

Next in the spirit of ISO 14001 standard we shall present the realisation of the software support concerning the presented softwares, software packages with regard to Environmental Protection Information Sub-system.

- *ENVIRONMENTAL POLICY (ISO 14001: 4.2.) & PLANNING (ISO 14001: 4.3.)*

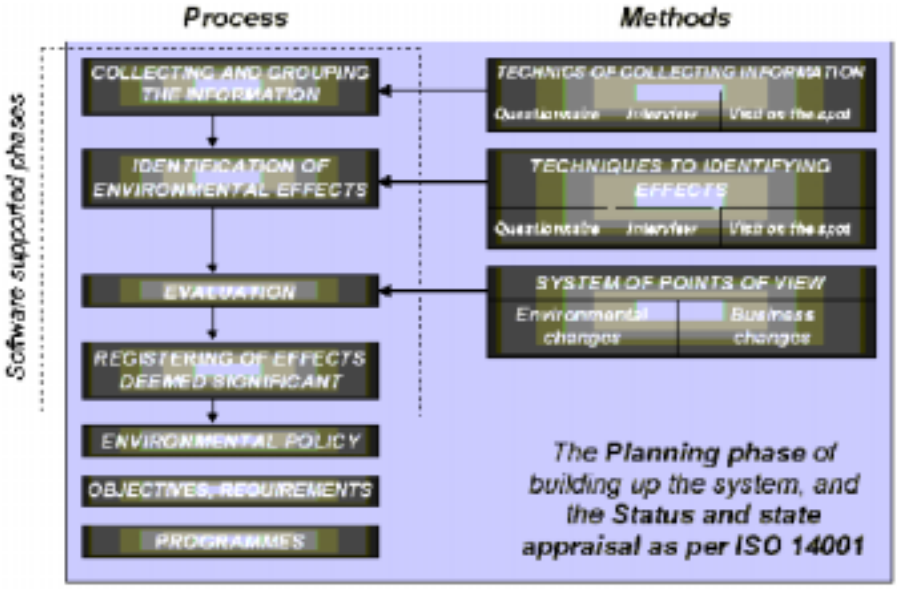

Fig. 5.

In connection with these requirements the following shall be identified:

- Any such past, present or future activity that has significant environmental effect
- The applicable laws, legal regulations and authorities' prescriptions

Here the *applied technologies* shall be appraised, after the evaluation of the *environmental factors* the *weighed, ranked list of essential effects* shall be made, the *essential effects shall be registered*, in order to be able to determine effective, precisely formed, measurable *environmental objectives*, and to realise them in course of *environmental management programmes* taking into consideration these effective *priorities*.

For the supporting of these phases on one hand the *TECHNO* software is capable, with the help of which the proper *modelling* and *controlling* of the *technologies* may be carried out in order to be able to exclude those technologies where the environmental effects are the most significant.

On the basis of these analyses, modelling the *measurable environmental objectives* can be realistically determined, since with the help of simulating the technologies we can easily model the probability of the future result of a possible 'improving attempt'.

With regard to the future activities concerning the technologies a *priority order* can be prepared, providing a basis for the effective building up of *environmental management programmes* and *planning* shall also be well founded.

The Environmental database can be prepared in this phase, that might make the basis for the future operation of the system with regard to the regularly repeating duties (audit reports, regular effect appraisals, justification of the improvement of the performance...). In the case of this more professional software the creation of the databases requires the involvement of highly qualified experts.

But, if we use the *QEMSRecord* and *QEMSBase* modules from the QEMS software package, then these phases might be done more easily from own sources.

In *QEMSBase* the environmental databases can be prepared, and with *QEMSRecord* the registering. Listing, ranking of environmental factors (air pollution, waste water emission, waste management, water usage, energy usage...) can be easily reached. With the help of the *QEMSAnal* and *QEMSQuery* modules the analysis and the evaluation – even with regard to periods connected to the life cycle of the product – can be easily effected.

Based on the phases of Status appraisal and Planning the Environmental policy, the environmental objectives and programmes supporting it, which can be actualised in an ever valid status with the help of *QEMSWord* module and can be accessed in a network system for the persons having the proper competence.

In *QEMSWord* the ever valid legal regulations are also accessible and reachable, hence ensuring the conformance with the authorities' and legal requirements.

With the help of the *TECHNO* programme a risk analysis can be performed, where the gained information offers a support in the decisions concerning special operational criteria in crisis situations.

- *REALISATION AND OPERATION (ISO 14001:4.4.)*

With regard to the structure and responsibilities certain modules of QEMS offer support with *competence* functions for certain activities, limiting also the *duties* and *responsibilities* of certain jobs.

With regard to controlling of the documents also the *QEMSWord* offers the solution.

- *CONTROLLING AND CORRECTIVE ACTIVITY (ISO 14001:4.5.)*

For simplifying and supporting the corrective and preventive activities and inner audits the analysing, querying, performance evaluating modules of *QEMS* are suitable.

- *MANAGEMENT SUPERVISION (ISO 14001:4.6.)*

Also essential information might be gained from and prepared from the querying, displaying modules and with the help of the listing functions of the softwares for the Management Supervisions for the first line management, so laying the foundations of the planning of the next period.

5. Realisation and Operation Phases

Next we shall summarise in draft the recommended phases of realisation and operation of the Environmental Management Information System:

REALISATION:

1. Determination of data structures (databases of hazardous waste materials, factories, products, equipment) being important from environmental protection point of view
2. Appointing the people (team members) needed for the realisation of the programme, determination of the partial duties, appointing the people having responsibility
3. Teaching the users, data entering
4. Integration, supervision of the partial databases entered

OPERATION:

1. Environmental effect evaluation and querying of the databases during the analysis
2. Operation of the system
   - Periodic duties
     - Giving the current production and emission data
     - Evaluation of the environmental performance for the given period, implementing the necessary measures into the EMS system
   - Continuous duties
     - Supporting the waste management duties
     - Handling of textual documents

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